

During the fiscal year 1903-4 Professor Reid kept a careful record of all earthquakes occurring in the United States about which any information could be obtained, either from the newspapers, the reports of the Weather Bureau and the Light-House Board, or by correspondence. Special information was collected regarding the earthquake of November 4, 1903, which was felt throughout a large section southeast of St. Louis, and also regarding that of March 21, 1904, which was felt in the extreme northeastern part of this country and in Nova Scotia.

Upon the invitation of the German Government, an international seismologic conference was held at Strassburg from July 24 to 28, 1904. The official delegates represented nineteen countries in various parts of the world, Professor Reid being the delegate from the United States. As a result of this conference the International Seismological Association was formed for the purpose of cooperative earthquake investigations, and it is expected that seismologic studies will be stimulated, especially in countries which have not heretofore been active in this field.

American observers and the correspondents of the MONTHLY WEATHER REVIEW are therefore invited to send reports of earthquakes to the Director of the U. S. Geological Survey for the use of Professor Reid. It is only in exceptional cases that such articles on this subject will hereafter be published in the MONTHLY WEATHER REVIEW, as we do not wish to duplicate his publications.

The first semiannual report by Professor Reid covering the months January to June, 1904, will be found in "Terrestrial Magnetism," June, 1905, Vol. X, pages 81-96. A fuller report will probably be published as a bulletin of the U. S. Geological Survey.

We have been requested to assist in distributing the following request for careful reports:

DESIDERATA RELATIVE TO EARTHQUAKES.

The U. S. Weather Bureau usually publishes in the monthly reports of the Climate and Crop Service, notices of earthquakes which have occurred in the respective States. The value of these reports would be greatly increased if more detail were given, especially with regard to the exact time of occurrence and the intensity of the shock.

When earthquakes are reported on the same day from various localities not very distant from each other, it may happen that they refer to the same disturbance or to different disturbances. If the exact times are recorded any uncertainty can, in general, be removed. In the compilation of general lists of earthquakes for all parts of the world, it is convenient to refer them all to some one standard of time, such as Greenwich mean time, but as the days in different parts of the world begin and end at different times, this is not possible unless the time of the disturbance is known and the local standard of time is mentioned.

Earthquakes of all intensities occur from those too small to be recorded even by the most delicate instruments to those of destructive violence. When the shock is unusually strong, much detail regarding it is apt to be given for that locality, but when it is only moderate, the record frequently states merely the fact that an earthquake was felt. Now, in studying earthquakes it is important to know the intensity of the wave of shock as it spreads outward over the globe, and it is, therefore, desirable that sufficient description of the local phenomena be given to allow the intensity of the shock to be expressed according to the Rossi-Forel scale, which is given below. This scale has been generally adopted by seismologists throughout the world.

ROSSI-FOREL SCALE.

I. Recorded by a single seismograph, or by some seismographs of the same pattern, but not by several seismographs of different kinds; the shock felt by an experienced observer.

II. Recorded by seismographs of different kinds; felt by a small number of persons at rest.

III. Felt by several persons at rest; strong enough for the duration or the direction to be appreciable.

IV. Felt by persons in motion; cracking of ceilings.

V. Felt generally by every one; ringing of some bells.

VI. General awakening of those asleep; general ringing of bells, stopping of clocks; visible disturbance of trees and shrubs; some startled persons leaving their dwellings.

VII. Fall of plaster; ringing of church bells; general panic; little or no damage to buildings.

VIII. Fall of chimneys; cracks in the walls of buildings.

IX. Partial or total destruction of some buildings.

X. Great disasters; ruins; disturbance of strata; fissures in the earth's crust; rock falls from mountains.

It is best for the individual local observers to describe as accurately as possible what the earthquake did and leave it to the student who compares all records to assign the scale values to the local intensities.

THE LIBBEY CIRCLE IN SEISMOLOGY.

In the annual report for 1904, part 1, page 44, of the British Association for the Advancement of Science, Professor Milne in his report on earthquakes refers to the "Libbey Circle" and enters it upon an accompanying chart. Undoubtedly Professor Milne refers back to the meeting of the British Association for the Advancement of Science in 1902 when Prof. William Libbey, of Princeton, was present and spoke at length upon what Professor Guyot was in the habit of calling the great zone of fracture about the globe.

This circle is a small circle of the globe having Bering Strait as a center or pole and a radius of about 80° of arc. It is found that a circle thus drawn cuts through all the depressed lands in the central portion of the globe.

Professor Guyot often referred to this region as the zone of fracture and one that contained five-sixths of the active volcanoes of the world. It stands in clear contrast with the great circle of volcanoes surrounding the Pacific basin. It is, in fact, a zone because a great circle will not exactly fit all these depressions, but a zone with slightly irregular borders and with this circle as an approximate median line will do so. Professor Guyot never referred to this zone as in any way connected with seismological phenomena, but Professor Libbey spoke of this part of the subject at the British Association for the Advancement of Science in 1902 at considerable length, and reported that he had a large amount of as yet unpublished evidence of very great seismic activity within this zone.

THE PICHE EVAPOROMETER.

In answer to some inquiries as to the coefficient to be used in the reduction of observations with the Piche evaporimeter, the Editor would refer inquirers to the article by Prof. Thomas Russell in the MONTHLY WEATHER REVIEW for September, 1888. As this number of the REVIEW is now entirely out of print the following summary of Professor Russell's results may be welcome.

The Piche evaporimeter (see fig. 1) consists of a glass tube about nine inches long and 0.4 inch internal diameter. The top is hermetically sealed; the lower end is closed by a disk of metal and a spring which holds a disk of porous paper in place. The tube being filled with water keeps the paper disk wet with a continuous supply of water to replace whatever is evaporated. The amount of evaporation is measured by the fall of the water in the tube. The supply should be so generous that the small disk of paper is kept wet even in the driest winds.

Twenty-five of these instruments were procured for the Signal Service in 1888; most of them were carefully compared with each other by weighing and with two standard shallow dishes of water from whose surfaces evaporation took place freely. The evaporating surface of the wet paper averaged 11.2 square centimeters or 1.182 square inches. The evapora-

ting surface of each dish was 33.65 square centimeters or 3.554 square inches and the dishes were 1.3 inches in depth.

Comparing equal surfaces of paper and water the Piches evaporated 1.33 times as much as the dishes when the dishes were full, but the ratio increased steadily up to 2.05 in proportion as the surface of the water in the dishes fell lower and lower. This is in accordance with all experience in evaporating water in dishes; probably the evaporation from a natural pond or reservoir diminishes in proportion as the surface of the water is below the level of the surrounding land, trees, or buildings. This diminution is due, of course, principally to the diminution of the wind at the surface of the water.

Experiments were made with different kinds of paper disks. A pad of the thickest sort of blotting paper evaporated more by 7 per cent than the thin, unsized paper furnished with the apparatus; this was apparently due principally to the additional surface exposed by the edge of the thick paper. The different Piche evaporimeters agreed with each other more closely than the different dishes of water. The height of water in the tube of the Piche evaporimeter or its pressure on the disk of paper made no appreciable difference in the evaporation. These comparisons were all made with apparatus installed in thermometer shelters, i. e., cubical boxes, three feet on a side, with open louvers, they therefore correspond to a very gentle movement of the wind over surfaces that are protected from the direct rays of the sun.

An anemometer set up inside the shelter gave velocities only one-half those recorded on the outside. It was found impossible to make any satisfactory allowance for the wind as recorded in the standard location of the anemometer. The average velocity of the wind for a year at all Signal Service stations was estimated to amount to about 8.5 miles per hour, and the general observations of evaporation must be considered as holding good for that velocity in the free air or one-half of that velocity in the shelter.

The effect of the wind on evaporation was determined by direct experiment, using the 28-foot whirling machine set up in the interior of the Pension Office Building, with which anemometers had been standardized. One Piche evaporimeter was suspended in the adjoining quiet air, the other fixed to the outer end of the long arm of the whirling machine and driven at a given rate of motion for half an hour, when both instruments were observed by very accurate weighing instead of the less accurate scale reading. Then the two Piche evaporimeters were interchanged and another similar set of observations made. The evaporation from the moving Piche was greater than that from the quiet one by the factors in the following table, which holds good for an average temperature of 83.7° F. and a relative humidity of 50 per cent:

| Velocity. Miles per hour. | Factor. |
|------------------------------|---------|
| 0 | 1.0 |
| 5 | 2.2 |
| 10 | 3.8 |
| 15 | 4.9 |
| 20 | 5.7 |
| 25 | 6.1 |
| 30 | 6.3 |

If barometric pressure is lowered the evaporation is increased, but no opportunity was offered for repeating these whirling experiments at very low pressures and they may be assumed to hold good for a barometric reading of 30.00 inches. On the other hand the evaporation computed for 30.00 inches

was reduced theoretically by Professor Russell for the effect of the low pressure at any given high station by using the ratio 30.00 inches divided by the mean pressure at the station as the barometric reducing factor.

As the amount of evaporation increases with the temperature and dryness of the air Professor Russell also reduced the observations at Washington to a theoretical value at any other station by using the additional factor

$$Ap_w + B(p_w - p_d)$$

where p_w is the vapor tension corresponding to the wet-bulb thermometer, and p_d is the vapor tension corresponding to the dew-point. Using the monthly means of observations at the eighteen stations occupied by the Signal Service the arbitrary coefficients A and B were determined so as to satisfy the whole range of observations, and Professor Russell found $A = 1.96$, $B = 43.9$.

It will be seen, therefore, that by means of the coefficient 1.33 Professor Russell passed from the Piche to the evaporation from the surface of water in dishes in shelters. By means of the tabular results of experiments with the whirling machine he passed from the wind in the shelter to the natural wind outdoors. By means of the barometric coefficient $30/b$ he passed from the lower to the higher altitudes. By the coefficients A and B he passed from the temperature and relative humidity prevailing in the shelter at Washington to the conditions prevailing at any point in the United States. Of course, however, this whole process was a series of approximations, and although it is the best that has yet been done, still it is in great need of revision.

The amount of evaporation from natural surfaces exposed to full sunshine can not be estimated even roughly from the records of observations made within instrument shelters. The latter may apply fairly well to forest areas, cloudy weather, and shaded mountain sides, but work in direct sunshine is needed in order to supplement the work done by Professor Russell. Such measurements under natural conditions have indeed been recorded by several investigators, notably Stelling, at St. Petersburg, Fitzgerald, at Boston, the Army Engineers, at Milwaukee, Wis., and more recently Carpenter, at Fort Collins, Colo. With the first of these results Professor Russell compares his own work and shows that if we assume a velocity of 3.5 miles per hour within the shelter at Boston, or 7.1 miles outside the shelter then the computed evaporation, 34.40 inches, agrees closely with the observed evaporation, 39.11, for one year. For New York the computed evaporation is 40.60 inches, the observed, at the Croton Waterworks, 39.21 inches.

For Milwaukee during three years, 1862, 1863, and 1864, but only during the warmer months of each year, observations were made by the Chief of Engineers by weighing a large shallow vessel filled with water set up inside a thermometer shelter. The mean of these three years, for the months of June to September, gave a total for these four months of 20.60 inches, the corresponding total computed by Professor Russell is 14.70, a large difference for which no explanation is offered. For the corresponding months at Chicago, in 1888, the Piche evaporimeter gave 23.87 inches, and the theoretical formula for normal atmospheric conditions gave 19.60 inches.

In both cases it is likely that the normal conditions assumed by the formula differed largely from the actual conditions of the years in question. In general, therefore, although Professor Russell's formula will hold good for the moist climate of the eastern United States it may give too small values for the hot, dry climate of the interior. He estimated its accuracy as correct within 20 per cent, but added that it must be remembered that the formula and the figures given by him for all Signal Service stations represent only the possibilities of evaporation under normal conditions, and not the actual evaporation occurring from natural surfaces.

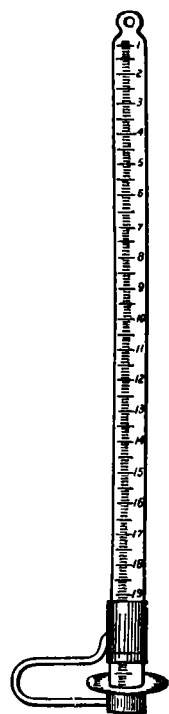


FIG. 1.

The Editor would again call attention to the principle laid down by him in discussing this subject in his *Treatise on Meteorological Apparatus and Methods*, viz, that evaporation as measured by any form of apparatus thus far devised corresponds to artificial conditions so far removed from nature that it can at best give only a crude representation of the actual natural evaporation by which moisture is thrown into the atmosphere from the ocean, the lakes, and the land. The true method of treating evaporimeters of all kinds within instrument shelters is to consider them as integrating hygrometers. For such exposures, the total evaporation during an hour, or a day, is a simple result of the temperature, the wind, and the dryness. Knowing the two former and the measured evaporation, we may compute the average dryness. This average dryness is a much more important datum to the meteorologist than is the measured evaporation to the climatologist. Of course, hydraulic and irrigation engineers need to know the loss of water by evaporation, but in nature this is so mixed up with seepage, leakage, and consumption by animals and plants that our meteorological data are of comparatively little importance. For the agricultural engineer the lysimeter and Symon's evaporimeter, six feet square, are essential apparatus, but for the meteorologist an integrating hygrometer, such as the Piche evaporimeter really is, is the important instrument. The meteorologist takes the atmosphere as it is, without necessarily concerning himself as to where the moisture comes from, and then tries to follow the air and vapor in all their kaleidoscopic changes.

THE ASSOCIATIONS OF TEACHERS OF PHYSICS AND MATHEMATICS.

Under the leadership of enthusiastic teachers in the universities and colleges, the teachers in normal schools, high schools, and academies are being organized into associations for mutual improvement. Three such associations are known to the Editor, viz, the Eastern Association, meeting usually in New England; the Middle States Association, meeting usually in New York or New Jersey; and the Central Association of Science and Mathematics Teachers, meeting usually in Chicago. Probably others also exist.

In all these associations the teaching of meteorology has received more or less attention and we commend the importance of such associations to the attention of those officials of the Weather Bureau who are interested in education.

The addresses of J. W. Smith, R. DeC. Ward, and William M. Davis before the Eastern Association on Saturday, May 20, 1905, and the addresses of Prof. H. J. Cox and the Editor before the Central Association on November 24, 1904, illustrate the importance of availing ourselves of these opportunities to further the meteorological propaganda.

WEATHER BUREAU MEN AS EDUCATORS.

Mr. Alfred F. Sims, Local Forecaster, Albany, N. Y., reports a visit from the class in physical geography of St. Agnes School, to which he gave instruction in the use of Weather Bureau instruments on April 27.

Mr. J. B. Marbury, Local Forecaster, Atlanta, Ga., reports that on June 10 the office of the Weather Bureau was visited by about forty members of the local Young Men's Christian Association to whom he gave a lecture on the work of the Weather Bureau which it is believed will lead to a more general appreciation of the service.

Mr. J. W. Smith, District Forecaster, Boston, Mass., reports that on May 20 he gave an address to the Eastern Association of Physics Teachers, and on the same date he also delivered a lecture to a class from Harvard University, and on June 3 to a class from the Mechanic Arts High School. In each of these ad-

resses he explained the organization, the work, and the beneficial results of the Weather Bureau. The lectures were given at the local Weather Bureau office.

Mr. David Cuthbertson, Local Forecaster, Buffalo, N. Y., reports that during May three classes from the public schools visited the office and received instruction in the rudiments of elementary meteorology.

Professor H. J. Cox, Chicago, Ill., under date of April 28, reports:

A committee, of which I am chairman, consisting of six members of the Geographic Society of Chicago, was recently appointed to prepare a bulletin on the teaching of meteorology, which is to be published by the society. Five members are teachers actively engaged in instruction in meteorology and physiography, among whom are Professor Goode and Mr. Barrows of the University of Chicago. It is believed that the work of the committee will afford great assistance to all engaged in teaching meteorology, and should meet with the cooperation of the Weather Bureau. It is the plan of the committee to supply lantern slides to teachers at actual cost (about \$3 per dozen). The following outline shows the subjects that the committee expects to illustrate, and the person to whom each subject is entrusted:

METEOROLOGY.

1. The atmosphere.—General considerations.
Illustrations of meteorological instruments.—Mr. Cox.
2. Temperature.
Illustrations: Charts of isotherms and other [charts of] heat distribution.—Miss Smith.
3. Air pressure and circulation.
Illustrations: Graphs of pressure records and wind records.
Diagrams for vertical circulation and meridional charts of circulations.—General.
Graphs of adiabatic vertical temperature gradient, and actual temperature gradient.
Charts of moonsoons.—Mr. Everly.
Weather maps of United States, etc.; cyclones, tornadoes, etc.—Mr. Cox, Mr. Goode.
Pictures of storm destruction, etc.; thunderstorms, etc.—Mr. Cox.
4. Moisture.
Illustrations: Graphs of moisture range.
Cloud forms (photographs).
Graphs of rainfall by months.
Charts of rainfall distribution.
Graphs on hail formation.
Photographs of hail or damage by hail.—Mr. Wilder.
Snow crystals, and frost scenes.
Snowscapes; sea ice.
Charts of humidity and evaporation.—Miss Smith.
5. Optics and electricity.
Illustrations: Mirage, coronæ, halos, rainbows, etc.; aurora borealis; lightning.—Mr. Barrows.
6. Climate.
Charts of United States and other regions.—Mr. Goode, Mr. Cox.

Under date of May 19 Professor Cox reports a lecture delivered May 5 before the Press Club of Chicago, and an address on May 12 before the Harmony Guild for the benefit of the charities of that organization. Both lectures were of a popular character and were highly appreciated.

Mr. W. P. Stewart, Assistant Observer, Escanaba, Mich., reports that on June 8 a class in physical geography from the Escanaba High School visited the office and were instructed in the use of instruments and maps, and methods of weather prediction.

Mr. D. S. Landis, Assistant Observer, Fort Worth, Tex., reports that during April two lectures were given to and visits received from scholars in the eighth and ninth grades in the High School.

Mr. B. L. Waldron, Observer, Hannibal, Mo., reports that the Principal with the senior class of the West School visited the Weather Bureau office on May 10 and were given a lecture on the construction and use of instruments, forecasting, and